ASSESMENT OF SEDIMENT YIELD IN LOWER DUDHANA BASIN

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ABSTARCT

This study aims to develop an MLR model for sediment yield estimation in the Dudhana river catchment, based on 18 hydrological, geological and topographical parameters. ANOVA analysis and correlation matrix were carried out to identify the most significant parameters, and 11 parameters were selected for the model development. The developed model has a correlation coefficient greater than 0.9, indicating a strong relationship between the selected parameters and sediment yield. The results of the study suggest that the developed correlation matrix can be used as a useful tool for the assessment of controlling factors as independent factors and sediment yield as dependent factor in the Dudhana river catchment, and may be applied to other similar catchments with comparable hydrological and geological conditions.

Introduction

Sediment yield estimation is an important aspect of water resource management and soil conservation in a catchment area (Yesuf et al. (2015), Xu et al. (2009), Talebizadeh et al. (2010)). The estimation of sediment yield can be done using various tools, each with its unique approach to estimate the sediment yield. Empirical models are the simplest and widely used tools for sediment yield estimation, which use the relationship between sediment yield and catchment characteristics, such as slope, vegetation cover, rainfall intensity, and soil type (Reddy and Reddy et al. (2015)). GIS-based models, on the other hand, estimate sediment yield by integrating spatial information of catchment characteristics like digital elevation model, land use, soil properties, rainfall data, and hydrological data. Hydrological models are also used to simulate the flow and sediment transport in a catchment by using inputs such as rainfall, soil properties, land use, and topography (Singh et al. (2014), Chandra et al. (2014), Reddy and Reddy et al. (2015)). Remote sensing techniques are gaining popularity in estimating sediment yield by analyzing changes in land cover and vegetation, using satellite data to estimate vegetation cover, soil moisture, and land use changes in the catchment area. The selection of a tool depends on the availability of data, the complexity of the catchment area, and the desired level of accuracy (Gupta et al. (2021). By using these tools, one can estimate the sediment yield from the catchment area, which is crucial for the proper management of water resources and soil conservation. Estimating sediment load from a catchment is a complex process that involves numerous uncertainties in the input data and model parameters. However, there are several sources of uncertainty that need to be considered while estimating sediment load from a catchment (Talebizadeh et al. (2010)). The primary sources of uncertainty in sediment load estimation are the input data and model parameters. Input data, such as rainfall, flow rates, and sediment concentration, are subject to measurement errors and uncertainties. These errors can be introduced during data collection, processing and analysis Talebizadeh et al. (2010). The quality of the input data can significantly impact the accuracy of the sediment load estimation. Moreover, model parameters such as erosion and deposition rates, sediment settling velocity, and hydraulic conductivity, are often determined through laboratory experiments or field measurements, which can introduce uncertainties. The (SWAT) Soil and Water Assessment Tool is a widely used by Im et al. (2007), Ayele et al. (2021), Duru et al. (2018) to model for estimating sediment yield from a catchment. The model integrates a range of hydrological and agricultural processes to simulate water flow and sediment transport from different land use and soil types. Chandra et al. (2014) used the SWAT sediment modelling on the Upper Tapi basin which is a large catchment in western India that has been subjected to significant land use changes and erosion over the past few decades. Estimating sediment yield from the Upper Tapi basin using the SWAT model can provide valuable information for managing soil and water resources in the region (Chandra et al. (2014).

In the present study Sediment yield modelling was carried out using multiple linear regression (MLR) To develop an importance of parameter, catchment characteristics that influence sediment yield are identified, and their relationship with sediment yield is quantified using statistical analysis of data. In addition to statistical analysis, geographic information systems (GIS) and remote sensing (RS) was also used to collect and analyse data on catchment characteristics such as land use, topography, and rainfall (Melesse et al. (2011), Nhu et al. (2020)). This data is then integrated with sediment yield measurements to develop an MLR model that can predict sediment yield for a specific catchment. The use of GIS and RS can help to provide accurate and up-to-date data on catchment characteristics and environmental conditions, which are important inputs for the MLR model. These tools can also provide a spatially explicit representation of the catchment, allowing for a more detailed analysis of the relationships between catchment characteristics and sediment yield. The resulting MLR model can then be used to predict sediment yield under different scenarios, such as changes in land use or climate conditions. The accuracy of the MLR model can be evaluated through statistical measures such as the coefficient of determination (R^2) and the root mean square error (RMSE). These measures can help to assess the performance of the model and identify areas for improvement. The use of GIS and RS can also provide a visual representation of the model output, allowing for a better understanding of the spatial distribution of sediment yield in the catchment.

Study Area

Dudhana river is a significant river that flows through the district of Jalna in the state of Maharashtra, India. It is a tributary of the Gadvari river, which is a major river in the region. The Dudhana river is an important water source for the people living in the region, and it contributes significantly to the agricultural industry in the area. The Dudhana River originates in the Balaghat range of hills in the southern part of the district, near the town of Ambad. It flows in a north-easterly direction, passing through the towns of Jalna and Badnapur before joining the Godavari River near the village of Sillewada. Location map of dudhan river is given in Figure 1. Table 2. Shows the Catchment, Climatic and Hydraulic Properties of the Dudhana River Catchment.

1. Data Collection

The data that is needed for sediment yield modeling using MLR technique are given below.

Precipitation data: This may include data on the amount, intensity, and distribution of precipitation in the study area. This data may be collected from weather stations or obtained from other sources, such as radar or satellite data. Rainfall data was collected form IMD.

Land use data: This may include data on the types of land cover in the study area, such as forests, cropland, or urban areas. This data is often used to model the effects of land use on the hydrologic cycle. LISS 3 data was used for deriving the LULC map.

Streamflow data: This may include data on the flow rate and volume of water in streams and rivers in the study area. This data is often used to model the movement of water through the watershed. Streamflow data was collected from the CWC (central water commission)

Topographic data: This may include data on the elevation, slope, and aspect of the land surface in the study area. This data is often used to model the movement of water across the landscape. Cartosat Data was used for basin delineation. Figure 2 and 3 shows the DEM and river network of Dudhana river respectively.

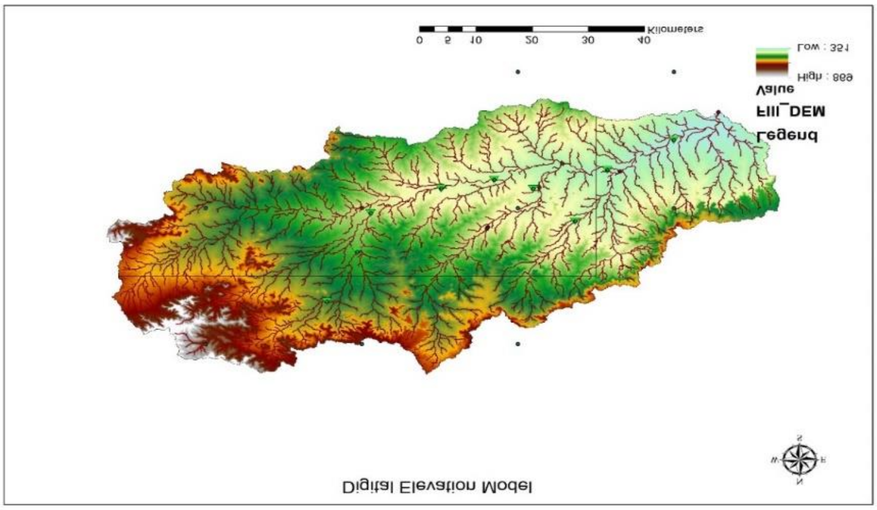

Figure 2 Digital Elevation Model

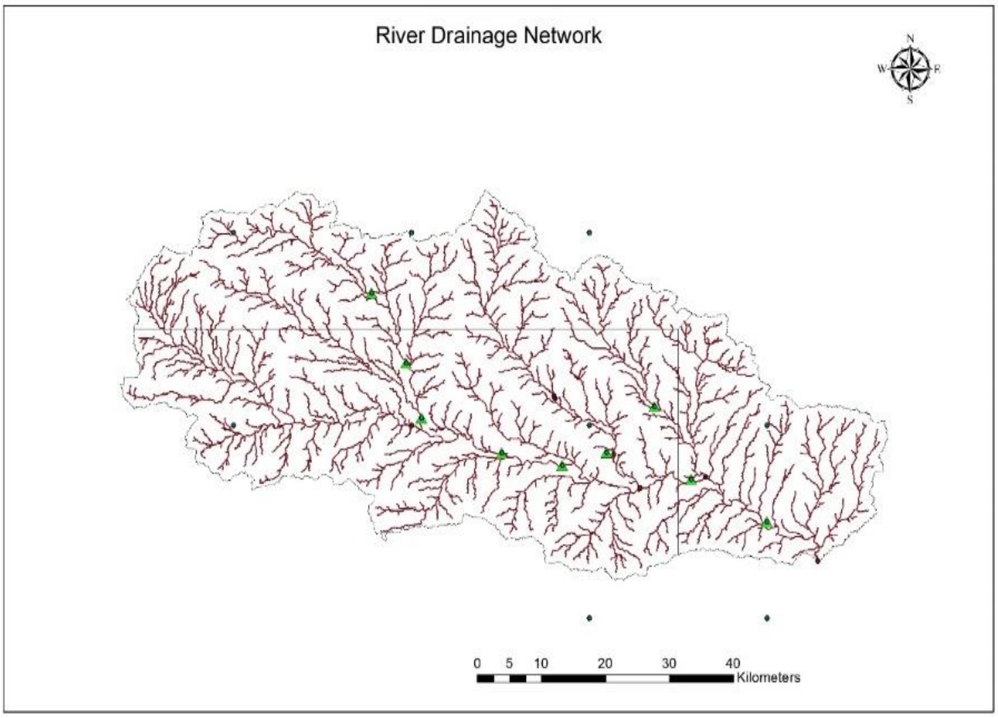

Figure 3 . River Drainage Network.

Table 2. Catchment, Climatic and Hydralic Properties of the Dudhana River Catchment.

Sbn	Precip	Area	Drainage Length	ElevMin	ElevMax	Elev Difference	Average Length	Slope	M_Elevation	RR	DD	HI	Water	Buitup	Agri	Rocky	Barren	Average FLOWOUTcms
0	9.92	211.32	163745.88	528.00	920.00	392.00	40449.14	0.01	646.54	0.01	0.77	0.43	2.45	39.82	8.45	141.17	14.37	2.55
1	10.44	448.10	356113.33	443.00	662.00	219.00	58980.85	0.00	520.96	0.00	0.79	0.55	2.27	121.59	21.95	183.21	117.63	6.71
2	9.65	75.04	59640.17	526.00	680.00	154.00	19744.73	0.01	580.05	0.01	0.79	0.54	1.72	13.35	5.62	46.12	7.90	1.07
3	11.13	237.81	195695.73	487.00	818.00	331.00	44874.58	0.01	585.78	0.01	0.82	0.43	0.93	49.72	11.80	113.27	60.55	3.53
4	10.49	116.34	76548.63	510.00	654.00	144.00	23697.92	0.01	552.65	0.01	0.66	0.42	1.14	22.30	8.70	61.65	21.40	1.79
5	10.18	266.27	201642.92	442.00	650.00	208.00	38935.48	0.01	506.07	0.01	0.76	0.45	2.92	64.96	26.29	102.68	67.67	3.59
6	10.67	386.19	332313.06	519.00	927.00	408.00	41162.27	0.01	600.23	0.01	0.86	0.25	3.13	124.03	41.21	177.52	34.80	5.35
7	10.09	184.45	149251.13	442.00	655.00	213.00	30043.97	0.01	496.31	0.01	0.81	0.34	1.56	20.66	11.95	107.05	39.74	2.46
8	10.68	91.26	11363.24	523.00	721.00	198.00	17941.92	0.01	563.77	0.01	0.12	0.26	0.04	29.70	12.80	32.06	15.98	1.31
9	10.77	170.74	106303.09	454.00	554.00	100.00	31533.65	0.00	492.52	0.00	0.62	0.63	1.34	22.14	11.15	90.42	44.02	2.06
10	10.95	84.55	60627.05	456.00	512.00	56.00	18558.93	0.00	484.21	0.00	0.72	1.02	1.49	20.70	17.88	18.57	24.44	1.23
11	11.02	135.43	111194.11	465.00	620.00	155.00	26213.36	0.01	501.41	0.01	0.82	0.31	2.11	31.94	19.27	52.14	30.02	2.08
12	10.99	119.61	88425.66	422.00	579.00	157.00	24161.96	0.01	471.80	0.01	0.74	0.46	0.80	23.17	21.05	58.63	15.91	1.84
13	11.53	130.74	97942.91	446.00	586.00	140.00	23734.33	0.01	479.20	0.01	0.75	0.31	0.00	14.74	33.54	44.16	36.77	1.76
14	11.69	99.18	58623.44	419.00	546.00	127.00	24573.73	0.01	467.26	0.01	0.59	0.61	1.26	14.66	34.68	28.23	13.49	1.29
15	11.21	160.53	42378.33	415.00	537.00	122.00	31831.96	0.00	462.70	0.00	0.26	0.64	0.00	0.09	0.03	0.70	0.09	2.17
16	10.71	56.75	42069.13	504.00	591.00	87.00	18672.54	0.00	528.78	0.00	0.74	0.40	0.00	12.80	5.27	10.98	26.18	4.20
17	10.06	18.49	13071.52	433.00	465.00	32.00	9641.86	0.00	448.05	0.00	0.71	0.89	0.00	1.03	1.72	10.61	4.82	6.25
18	11.18	269.84	209347.58	482.00	692.00	210.00	35114.81	0.01	523.80	0.01	0.78	0.25	0.85	46.13	24.76	102.07	92.11	10.41
19	11.08	32.24	26926.14	489.00	550.00	61.00	11674.48	0.01	514.26	0.01	0.84	0.71	0.00	2.78	1.24	18.50	9.72	6.42
20	11.17	5.72	4251.70	483.00	515.00	32.00	5213.84	0.01	492.26	0.01	0.74	0.41	0.00	0.47	0.58	1.79	2.71	10.01
21	11.16	126.35	95828.11	464.00	611.00	147.00	31580.44	0.00	500.31	0.00	0.76	0.33	0.04	19.50	11.51	56.85	35.79	22.13
22	10.55	23.00	17258.35	457.00	490.00	33.00	12088.79	0.00	471.01	0.00	0.75	0.74	0.00	3.89	3.79	6.35	8.96	24.57
23	10.72	17.19	12063.91	453.00	489.00	36.00	8657.35	0.00	468.55	0.00	0.70	0.76	0.00	1.33	2.19	2.91	10.77	26.08
24	10.35	14.81	11782.30	447.00	476.00	29.00	7862.15	0.00	458.56	0.00	0.80	0.66	0.00	1.44	3.14	0.85	9.35	28.37
25	10.36	6.45	6646.06	445.00	462.00	17.00	5156.31	0.00	452.17	0.00	1.03	0.73	0.00	0.26	0.69	0.17	1.06	30.17
26	10.26	44.23	31957.04	435.00	500.00	65.00	16339.27	0.00	457.71	0.00	0.72	0.54	0.00	2.07	4.13	21.05	16.81	37.84
27	10.97	364.24	270383.45	420.00	661.00	241.00	43888.27	0.01	464.16	0.01	0.74	0.22	3.57	68.79	55.21	188.82	40.09	49.11
28	10.41	2.91	5187.87	417.00	432.00	15.00	3522.00	0.00	425.18	0.00	1.78	1.20	1.94	0.45	0.43	0.08	0.00	50.97
29	10.35	27.88	8282.35	412.00	451.00	39.00	12606.34	0.00	428.47	0.00	0.30	0.73	2.78	1.73	2.51	0.34	0.04	52.64
30	10.30	75.93		407.00	457.00	50.00	20815.29	0.00	430.84	0.00	0.00	0.91						55.87

Methodology

A sediment yield model is an important tool in water resources management and planning. The model can help to estimate the amount of sediment that will be transported by a river or stream in a given catchment, which is important information for many water resources applications. One key area where sediment yield models are important is in the design of hydraulic structures, such as dams and bridges. Sediment transport can cause erosion and damage to these structures, and sediment buildup can reduce their storage capacity. By estimating sediment yield, engineers can design structures that are more resilient to sediment transport, reducing the need for maintenance and repair. Sediment yield models are also important in predicting the impacts of land use change and climate change on sediment transport. For example, changes in land use, such as deforestation or urbanization, can increase sediment yield in a catchment. By modeling these changes, policymakers and land managers can identify areas where interventions are needed to reduce sediment transport and improve water quality. In addition, sediment yield models can help to manage sediment-related environmental problems, such as soil erosion and sedimentation of waterways. By predicting sediment yield, managers can develop strategies to reduce soil erosion and sediment transport in the catchment, such as implementing conservation practices or restoring riparian vegetation. Overall, sediment yield models are important in water resources management and planning as they provide critical information for designing hydraulic structures, predicting the impacts of land use and climate change, and managing sediment-related environmental problems. The methodology for making a sediment yield model using multiple linear regression (MLR), GIS and RS data, rainfall data and flow data can be broadly divided into the following steps:

1. Data collection: The first step in developing an MLR model for sediment yield estimation is to collect data on catchment characteristics, such as land use, topography, soil type, and geology. This data can be obtained from GIS and RS sources. Additionally, rainfall data and flow data from stream gauges within the catchment should be collected.
2. Data preprocessing: The collected data needs to be preprocessed to make it suitable for analysis. This may involve cleaning, filtering, and aggregating the data to the appropriate spatial and temporal scales.
3. Statistical analysis: The relationships between the catchment characteristics, rainfall, flow and sediment yield need to be quantified using statistical analysis techniques such as correlation analysis, regression analysis, and factor analysis. The aim is to identify the most significant variables that affect sediment yield in the catchment.
4. Model development: Using the significant variables identified in the statistical analysis, an MLR model can be developed to estimate sediment yield in the catchment. The model equation will be a linear combination of the significant variables, with coefficients estimated through regression analysis.
5. Model validation: The developed model needs to be validated to ensure its accuracy and reliability. This can be done using statistical measures such as R^2 and RMSE. The model should also be tested against new data that were not used in model development.
6. Model refinement: The developed model can be refined by including additional catchment characteristics, rainfall and flow data or by testing different combinations of variables to improve model accuracy.

7. Model application: Once the model is validated and refined, it can be used to estimate sediment yield in the catchment under different scenarios, such as changes in land use, rainfall patterns or flow regime.

Multiple Linear Regression (MLR) is a statistical method used to develop a sediment yield model based on multiple independent variables or parameters. In this case, the independent variables or parameters used are *Precipitation (Precip), Basin Area, Drainage Length, Elevation Minimum (Elevation Min), Elevation Maximum (Elevation Max), Elevation Difference, Average Length of Basin, Slope, Mean Elevation, Relief Ratio, Drainage Density, Human Impact Index (HI), Water Area, Builtup Area, Agricultural Area, Rocky Area, Barren Area, and Average Flow*. The MLR model uses a linear equation that relates the dependent variable, in this case, sediment yield, to the independent variables.

To develop the MLR model for sediment yield, data on sediment yield and the independent variables are collected from the study area. The data are then analyzed using statistical software to obtain the regression coefficients for the equation. The regression coefficients represent the change in sediment yield for a one-unit change in the corresponding independent variable, holding all other variables constant. Once the MLR model is developed, it can be used to predict sediment yield in other catchments with similar characteristics. The model can also be used to evaluate the relative importance of each independent variable in determining sediment yield. This information can be used to identify the factors that contribute most to sediment yield and to prioritize management practices for reducing sediment yield in a given catchment.

Matrix 1. Correlation ,atrix for parameter selection.

Precipitation (Precip), Basin Area, Drainage Length, Elevation Minimum (Elevation Min), Elevation Maximum (Elevation Max), Elevation Difference, Average Length of Basin, Slope, Mean Elevation, Relief Ratio, Drainage Density, Human Impact Index (HI), Water Area, Builtup Area, Agricultural Area, Rocky Area, Barren Area, and Average Flow (FLOWOUT) in cms. Sediment yield (SEDOUT) in tons/Year

	Precip	*Area*	*Drainage Length*	*ElevMin*	*ElevMax*	*Elev Difference*	*Average Length*	*Slope*	*Mean Elevation*	*RR*	*DD*	*HI*	*Water*	*Buitup*	*Agri*	*Rocky*	*Barren*	*Average FLOW OUTcms*	*SED OU Ttons/Year*
Precip	1.00																		
Area	0.09	1.00																	
Drainage Length	0.03	0.98	1.00																
ElevMin	-0.14	0.12	0.14	1.00															
ElevMax	-0.03	0.71	0.71	0.68	1.00														
Elev Difference	0.01	0.81	0.80	0.47	0.97	1.00													
Average Length	0.11	0.95	0.91	0.13	0.72	0.82	1.00												
Slope	-0.02	0.35	0.34	0.71	0.83	0.76	0.33	1.00											
M_Elevation	-0.13	0.46	0.47	0.89	0.91	0.79	0.51	0.80	1.00										
RR	-0.02	0.35	0.34	0.71	0.83	0.76	0.33	1.00	0.80	1.00									
DD	-0.08	-0.01	0.08	0.04	0.00	-0.01	-0.12	0.00	0.01	0.00	1.00								
HI	-0.25	-0.54	-0.52	-0.46	-0.68	-0.66	-0.54	-0.65	-0.55	-0.65	0.18	1.00							
Water	-0.25	0.64	0.66	-0.03	0.45	0.55	0.56	0.25	0.24	0.25	0.15	-0.15	1.00						
Buitup	-0.01	0.93	0.95	0.23	0.71	0.77	0.83	0.39	0.50	0.39	0.03	-0.46	0.65	1.00					
Agri	0.38	0.72	0.72	-0.07	0.46	0.57	0.62	0.31	0.16	0.31	-0.05	-0.52	0.57	0.68	1.00				
Rocky	-0.07	0.94	0.96	0.21	0.78	0.85	0.89	0.45	0.54	0.45	0.05	-0.56	0.68	0.89	0.69	1.00			
Barren	0.12	0.80	0.81	0.06	0.44	0.50	0.78	0.08	0.29	0.08	0.03	-0.42	0.34	0.74	0.50	0.72	1.00		
Average FLOWOUTcms	-0.22	-0.25	-0.20	-0.53	-0.49	-0.40	-0.32	-0.47	-0.60	-0.47	0.05	0.41	0.13	-0.21	-0.11	-0.18	-0.26	1.00	
SEDOUTtons/Year	-0.24	0.61	0.66	0.41	0.80	0.82	0.58	0.62	0.68	0.62	0.09	-0.30	0.55	0.71	0.32	0.68	0.28	-0.19	1.00

Results and Discussions

The ANOVA table summarizes the sources of variation in the model and calculates the F-statistic and associated p-value to test the null hypothesis that all the regression coefficients are equal to zero. ANOVA table will include the following components as shown in table 2.:

- Sum of squares (SS): measures the total amount of variation in the response variable (SEDOUT) that is explained by the model and the residual variation that is not explained by the model.
- Degrees of freedom (df): the number of independent observations in the dataset minus the number of parameters estimated in the model.
- Mean square (MS): the sum of squares divided by the degrees of freedom, which represents the variance of the source of variation.
- F-statistic: the ratio of the mean square for the model to the mean square for the residual, which tests the significance of the model as a whole.
- p-value: the probability of observing an F-statistic as extreme as the one calculated under the null hypothesis of no relationship between the predictor variables and the response variable.

The ANOVA table will also include the regression coefficients (β) for each predictor variable, along with their standard errors, t-statistics, and associated p-values. The t-statistic tests the null hypothesis that the true value of the regression coefficient is zero, and the p-value indicates the probability of observing a t-statistic as extreme as the one calculated under the null hypothesis.

Table 2. ANOVA Table for the all the parameters considered in the present study.

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4.84798E+12	18	2.6933E+11	21.72617644	2.86901E-53	1.622172
Within Groups	6.99172E+12	564	1.2397E+10			
Total	1.18397E+13	582				

A large F-value suggests that there is a significant difference between the means of the groups. However, there is no specific value that can be considered "good" for the F-value. The interpretation of the F-value depends on the degrees of freedom and the sample size. Generally, a larger F-value indicates a larger difference between the means of the groups, but the significance of this difference depends on the P-value. F crit in the above table is 1.6 and F is far less than the F crit . Generally, an F-value greater than or equal to 1.0 is considered a good indicator of group differences, but the threshold for the F-value may vary depending on the context of the study. calculated F-value is greater than the critical F-value, then the differences among the groups' means are statistically significant.

MLR Modelling of Sediment yield

Developing the MLR model of sediment yield needs several statistics to be considered. The selected parameters for the MLR model play an important role in accurately estimating the sediment yield from a catchment. Precipitation, drainage length, slope, elevation difference, and mean elevation are all physical characteristics of the catchment that influence the sediment yield. Higher precipitation can lead to more runoff and erosion, while longer drainage length and steeper slopes can increase the velocity of runoff and the amount of sediment transported. Elevation difference and mean elevation can also affect the amount of sediment transported by influencing the energy of the flowing water. Human activities in the catchment such as urbanization, and Rocky area can also affect the sediment yield. Hence, variables such as built-up area, agricultural area, rocky area, and HI (Human influence) were selected as parameters. Water flow is also a significant factor affecting sediment yield, and thus, average flow-out cms was considered as a parameter. The selection of these parameters was based on their statistical significance, correlation with the sediment yield, and their influence on the physical and anthropogenic factors affecting sediment yield in the catchment.

The R-squared (R^2) value measures the proportion of the total variation in the sediment yield that can be explained by the independent variables in the model. A high R^2 value close to 1 suggests that the model can explain a large portion of the variation in sediment yield. On the other hand, a low R^2 value close to 0 indicates that the model is not a good fit for the data. In the present study R^2 value is 0.96 indicates the performance of the model is good. The Adjusted R-squared (0.92) is a similar measure, but it takes into account the number of independent variables in the model. The Standard error is another important statistic to consider. It measures the average deviation of the observed values from the predicted values in the model. A low standard error indicates that the model is able to accurately predict the sediment yield.

Table 3. Regression Statistics of MLR model.

Regression Statistics	
Multiple R	0.953667
R Square	0.909481
Adjusted R Square	0.854164
Standard Error	183610.8
Observations	30

Table 4 indicates the coefficient of each variable and standard error. Since the p-value = 0.02 < .05 = α, we conclude that the regression model is a significantly good fit. Final form of the equation can be written as:

Standard Residuals was plotted for the developed model as shown in Figure 2. Standard Residuals in a regression model indicate the difference between the actual and predicted values of the dependent variable, expressed in terms of the standard deviation of the residuals. A residual is the difference between the observed value of the dependent variable and its predicted value based on the regression model. The standard residuals are obtained by dividing the residuals by the standard deviation of the residuals. Standard residuals are expressed in units of standard deviation, which makes it easier to compare the magnitude of the residuals across different data sets or models. Specifically, the residuals should be normally distributed around a mean of zero, and there should be no pattern or trend in the residuals as a function of the predicted values. From the figure it can be clearly seen that Standard Residuals is close to zero and doesn't fallow any particular trend indicating the good capability of developed model in estimating the sediment yield.

Conclusions

This study aims to develop to impotence of linkages of controlling variables for sediment yield estimation in the Dudhana river catchment, based on 18 hydrological, geological and topographical parameters. From the study it can be concluded that the estimation of sediment yield is a complex process that involves various factors such as hydrological, geological and topographical parameters. The use of MLR models for sediment yield estimation is a popular approach, which can effectively predict sediment yield based on selected parameters. In this study, an MLR model was developed for sediment yield estimation in the Dudhana river catchment. The relationship between the catchment characteristic rainfall, flow and sediment yield needed to be quantified using statistical analysis techniques such as correlation analysis, regression analysis and factor analysis. The aim is to identify the most significant variables that affects sediment yield in catchment. Using the significant variable identified in the statical analysis. The study highlights the importance of sediment yield estimation in water resources management, as it helps in the assessment of soil erosion, sedimentation in reservoirs, and impacts on aquatic ecosystems. The use of advanced techniques such as GIS, RS and machine learning models like MLR and ANN can improve the accuracy and efficiency of sediment yield estimation, thus aiding in the effective management of water resources.

REFERENCES

Ayele, G. T., Kuriqi, A., Jemberrie, M. A., Saia, S. M., Seka, A. M., Teshale, E. Z., ... & Melesse, A. M. (2021). Sediment yield and reservoir sedimentation in highly dynamic watersheds: the case of Koga Reservoir, Ethiopia. *Water*, *13*(23), 3374.

Ayele, G. T., Kuriqi, A., Jemberrie, M. A., Saia, S. M., Seka, A. M., Teshale, E. Z., ... & Melesse, A. M. (2021). Sediment yield and reservoir sedimentation in highly dynamic watersheds: the case of Koga Reservoir, Ethiopia. *Water*, *13*(23), 3374.

Banadkooki, F. B., Ehteram, M., Ahmed, A. N., Teo, F. Y., Ebrahimi, M., Fai, C. M., ... & El-Shafie, A. (2020). Suspended sediment load prediction using artificial neural network and ant lion optimization algorithm. *Environmental Science and Pollution Research*, *27*, 38094-38116.

Briak, H., Moussadek, R., Aboumaria, K., & Mrabet, R. (2016). Assessing sediment yield in Kalaya gauged watershed (Northern Morocco) using GIS and SWAT model. *International Soil and Water Conservation Research*, *4*(3), 177-185.

Chandra, P., Patel, P. L., Porey, P. D., & Gupta, I. D. (2014). Estimation of sediment yield using SWAT model for Upper Tapi basin. *ISH Journal of Hydraulic Engineering*, *20*(3), 291-300.

Duru, U., Arabi, M., & Wohl, E. E. (2018). Modeling stream flow and sediment yield using the SWAT model: a case study of Ankara River basin, Turkey. *Physical Geography*, *39*(3), 264-289.

Eisazadeh, L., Sokouti, R., Homaee, M., & Pazira, E. (2012). Comparison of empirical models to estimate soil erosion and sediment yield in micro catchments. *Eurasian Journal of Soil Science*, *1*(1), 28-33.

Gupta, D., Hazarika, B. B., Berlin, M., Sharma, U. M., & Mishra, K. (2021). Artificial intelligence for suspended sediment load prediction: a review. *Environmental Earth Sciences*, *80*(9), 346.

Im, S., Brannan, K. M., Mostaghimi, S., & Kim, S. M. (2007). Comparison of HSPF and SWAT models performance for runoff and sediment yield prediction. *Journal of Environmental Science and Health, Part A*, *42*(11), 1561-1570.

Khoi, D. N., & Suetsugi, T. (2014). The responses of hydrological processes and sediment yield to land-use and climate change in the Be River Catchment, Vietnam. *Hydrological Processes*, *28*(3), 640-652.

Malik, A., Kumar, A., & Piri, J. (2017). Daily suspended sediment concentration simulation using hydrological data of Pranhita River Basin, India. *Computers and Electronics in Agriculture*, *138*, 20-28.

Melesse, A. M., Ahmad, S., McClain, M. E., Wang, X., & Lim, Y. H. (2011). Suspended sediment load prediction of river systems: An artificial neural network approach. *Agricultural Water Management*, *98*(5), 855-866.

Mustafa, M. R., Rezaur, R. B., Saiedi, S., & Isa, M. H. (2012). River suspended sediment prediction using various multilayer perceptron neural network training algorithms—a case study in Malaysia. *Water resources management*, *26*, 1879-1897.

Nhu, V. H., Khosravi, K., Cooper, J. R., Karimi, M., Kisi, O., Pham, B. T., & Lyu, Z. (2020). Monthly suspended sediment load prediction using artificial intelligence: testing of a new random subspace method. *Hydrological Sciences Journal*, *65*(12), 2116-2127.

Nourani, V., Baghanam, A. H., Adamowski, J., & Kisi, O. (2014). Applications of hybrid wavelet–artificial intelligence models in hydrology: a review. *Journal of Hydrology*, *514*, 358-377.

Pandey, A., Himanshu, S. K., Mishra, S. K., & Singh, V. P. (2016). Physically based soil erosion and sediment yield models revisited. Catena, 147, 595-620.

Reddy, A. S., & Reddy, M. J. (2015). Evaluating the influence of spatial resolutions of DEM on watershed runoff and sediment yield using SWAT. *Journal of Earth System Science*, *124*, 1517-1529.

Singh, A., Imtiyaz, M., Isaac, R. K., & Denis, D. M. (2014). Assessing the performance and uncertainty analysis of the SWAT and RBNN models for simulation of sediment yield in the Nagwa watershed, India. *Hydrological Sciences Journal*, *59*(2), 351-364.

Talebizadeh, M., Morid, S., Ayyoubzadeh, S. A., & Ghasemzadeh, M. (2010). Uncertainty analysis in sediment load modeling using ANN and SWAT model. *Water Resources Management*, *24*, 1747-1761.

Vanmaercke, M., Poesen, J., Govers, G., & Verstraeten, G. (2015). Quantifying human impacts on catchment sediment yield: A continental approach. *Global and Planetary Change*, *130*, 22-36.

Verstraeten, G., & Poesen, J. (2001). Factors controlling sediment yield from small intensively cultivated catchments in a temperate humid climate. *Geomorphology*, *40*(1-2), 123-144.

Xu, Z. X., Pang, J. P., Liu, C. M., & Li, J. Y. (2009). Assessment of runoff and sediment yield in the Miyun Reservoir catchment by using SWAT model. *Hydrological Processes: An International Journal*, *23*(25), 3619-3630.

Yesuf, H. M., Assen, M., Alamirew, T., & Melesse, A. M. (2015). Modeling of sediment yield in Maybar gauged watershed using SWAT, northeast Ethiopia. *Catena*, *127*, 191-205.